Westinghouse Program Overview

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Introduction

The Westinghouse Solid Oxide Fuel Cell Development Program continues to make steady progress towards commercialization. The vision of a cost-competitive, ultra-high efficiency, environmentally friendly SOFC power generation product line for distributed power and cogeneration applications is nearing a reality. This vision is centered around Pressurized SOFC/Gas Turbine (PSOFC/GT) combined cycle power generation systems in the hundreds of kWe's to tens of MWe's power range, which are capable of producing electricity at efficiencies between 62% and 72% depending on size, configuration and equipment selection. This paper summarizes 1) our important technical accomplishments over the past few years, 2) our final phase development program covering the time-frame 1997 to 2001, and 3) our vision of a commercial enterprise structure including partners.

Objectives

The objective of the Westinghouse SOFC Development Program is to complete the development of atmospheric SOFC power systems and PSOFC/GT power systems for cogeneration and distributed power applications, and initiate commercial manufacture of such systems by 2001.

Approach

The Westinghouse SOFC Development Program is multi-faceted and consists of the following major tasks: cell cost reduction, module scale-up and cost reduction, system (balance-of-plant) scale-up and cost reduction, field unit program, and commercial manufacturing facility design and construction. This final phase development program will cover the time span 1997-2002. In order to secure non-Federal funds for cost share obligations and for construction of the commercial manufacturing facility, and to selectively augment the existing skills and capabilities in such areas as ceramic manufacturing, automation, gas turbine technology, market access and distribution channels, etc., Westinghouse has been negotiating with a number of other corporations concerning the formation of a Joint Venture for the purpose of commercializing SOFC.

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Project Description

The cell development tasks are focused on developing lower cost materials and ceramic manufacturing processes for our commercial size (2.2 cm O.D., 150 cm active length) air electrode supported cell. The nominal material composition of each cell component has been fixed, and the evaluation of lower grade (i.e., lower purity) raw materials is in progress. Over the last several years, Westinghouse has made significant progress in developing lower cost manufacturing processes; plasma spray of the interconnection has replaced the more expensive electrochemical vapor deposition (EVD) process in production and fuel electrode slurry dipping/sintering intended to replace fuel electrode slurry spray/EVD has been successfully developed in the laboratory. Implementation in production is expected by mid-1998.

The module development tasks are focused on scale-up, pressurization, and cost reduction. A cell stack, consisting of 1152, commercial size, air electrode supported cells with integral stack reformers and having a maximum power output at 1 atmosphere pressure of 170 kWe DC, has been fully designed and built for the EDB/ELSAM Field Unit described below. The above stack design will form the basis of the stack designs in our field unit program described below, and in our commercial modules.

The field unit program consists of 3 field unit tests: 1) the EDB/ELSAM (Dutch/Danish utilities) 100 kWe, atmospheric cogeneration system scheduled for start of site testing in December 1997, 2) the SCE 250 kWe, PSOFC/GT combined cycle system scheduled for start of site testing in January 1999, and 3) the MWe-Class PSOFC/GT system at EPA's Fort Meade, MD laboratory scheduled for start of site testing in 2000. The first field unit will demonstrate the performance of the commercial size cell in large quantities and the new stack components including the stack reformers. The second field unit is a first-of-a-kind test demonstrating the coupling of a PSOFC module and a gas turbine at 3-4 atmospheres pressure. Finally, the third field unit is a demonstration of a multi-module commercial prototype system. Both PSOFC/GT field units are expected to have an electrical efficiency in the 60-65% range. In addition, a task to upgrade the MWe-class system to a 70% efficient system is included in our field unit program.

Assuming the success of the cost reduction tasks and field unit program, a decision to build the first commercial production line will be made around mid-1999. Construction is estimated to take about 2 years. Thus commissioning of the commercial manufacturing facility is expeected by mid-2001.

Accomplishments

The SOFC Power Generation organization is proud of and encouraged by its technical accomplishments over the past few years. The major accomplishments include:

- Over 13,000 hours (1½ years) of power operation for a 25 kWe SOFC power generation system with approximately 0.1% voltage degradation per 1000 hours of operation,

- Nearly 7½ years of power operation for two cells with a voltage degradation rate of about 0.5% per 1000 hours,

- Successful development of our air electrode supported cell, and successful scale-up from a 50 cm active length cell (65 watts per cell at 1 atmosphere) to a 150 cm active length, larger diameter cell (210 watts per cell at 1 atmosphere),

- Construction, commissioning, and operation of a 4 MWe per year Pilot Manufacturing Facility,

- Completion of the manufacturing of the 100 kWe (150 kWe max.) cogeneration power system for EDB/ELSAM (a Dutch and Danish Utility Consortium), and

- Successful pressurized cell testing up to 15 atmospheres in collaboration with Ontario Hydro achieving a SOFC cell power output record of 280 watts.

Benefits

This program is expected to culminate in a MWe-class product offering having an electrical efficiency of at least 63% on natural gas, an NOx emission of ≤2 ppmV, and a total installed cost of $1500/kWe or less.

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